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Ice Age Lamps

The invention of fat-burning lamps toward the end of the Ice Age helped to transform European culture. It coincided with several other major technological advances

by Sophie A. de Beaune and Randall White

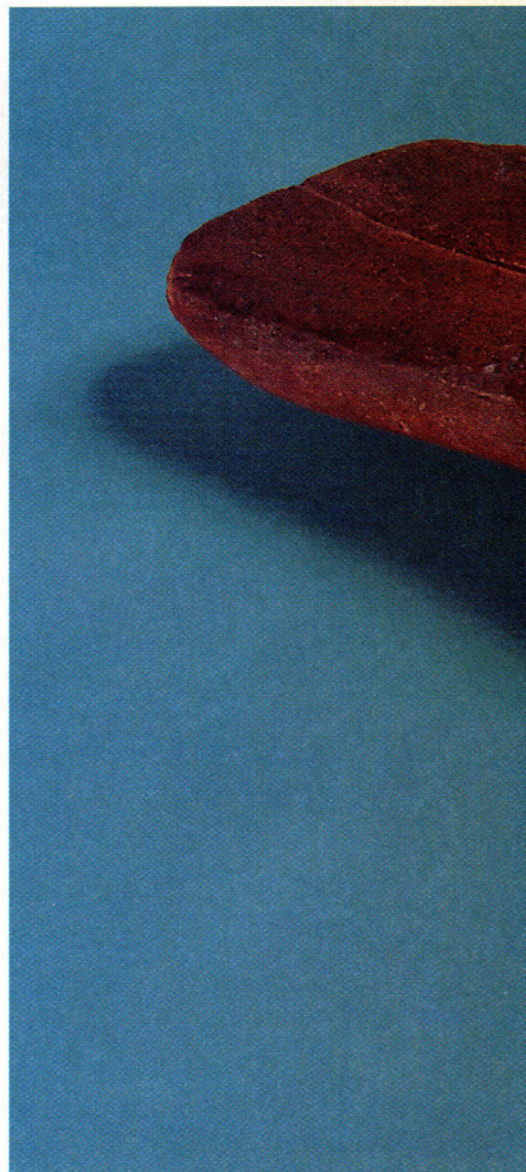
The controlled use of fire, first achieved at least half a million years ago, is one of the great innovations in human culture. Although archaeologists and anthropologists generally emphasize the importance of fire for cooking, warmth and protection from predators, the light accompanying fire was also a precious resource, one that made it possible to extend human activity to times and places that are naturally dark. The invention of stone, fat-burning lamps, which happened in Ice Age Europe nearly 40,000 years ago, offered the first effective, portable means of exploiting this aspect of fire. The appearance of lamps broadly coincides with a number of other extraordinary cultural changes, including the emergence of art, personal adornment and complex weapons systems.

Many scholars have hypothesized about how Ice Age lamps functioned and were used, but nobody had ever undertaken a systematic study of them.

One of us (de Beaune) therefore set out to examine these lamps in detail and to classify them by type. In conjunction with that project, we built working replicas of stone lamps in order to analyze their effectiveness as light sources and to learn about their design, fabrication and use. The results of this investigation provide a provocative insight into the technology and behavior of some of the earliest modern humans in Europe.

The first object explicitly identified as an Ice Age lamp was discovered in 1902, the year researchers authenticated the wall art in the cave at La Mouthe, France. Archaeologists had presumed that the creation of paintings and engravings hundreds of meters underground must have required an artificial light source. In the course of exploring La Mouthe, they uncovered compelling support of that notion: a carefully fabricated and heavily burned sandstone lamp bearing the engraved image of an ibex on its underside.

quickly became obvious that the size and shape of an object are insufficient as defining criteria. For example, lamps need not have a bowl-shaped depression; many perfectly flat slabs show clear traces of localized burning, which in these and other instances provide



SOPHIE A. DE BEAUNE and RANDALL WHITE share a fascination with the culture and technology of Ice Age humans. De Beaune is a member of the Laboratory of Prehistoric Ethnology at the National Center for Scientific Research (CNRS) in Paris. She also teaches biological and cultural anthropology to high school students in France. Her current research focuses on nonflint artifacts from the Paleolithic era; she has participated in and directed several excavations in southwest France. White is an associate professor of anthropology at New York University. He specializes in Upper Paleolithic art and technology and is currently preparing a monograph on the earliest forms of personal adornment among European cultures. White co-edited *French Upper Paleolithic Collections in the Logan Museum of Anthropology*, which brought to light important late Ice Age art and artifacts in an important U.S. repository. De Beaune contributed most of the new research for this article, which White has helped place in a broader scientific context.

Since then, hundreds of more or less hollowed-out objects have been excavated and rather indiscriminately lumped into the category of lamps. The initial research goals were to sift through the potpourri, establish criteria for identifying lamps and examine variation within this category of objects. A search of the literature and of museum collections turned up 547 artifacts that had been listed as possible lamps. The first hurdle was to distinguish lamps from other similarly shaped implements, such as grinding stones. It

CARVED-HANDLE LAMP, 17,500 years old, represents one of the most elaborate designs used by Paleolithic humans in France. The lamp consists of abraded red sandstone. The bowl holds a fatty fuel and wick; the long handle keeps the end of the lamp cool. Engravings on the handle resemble patterns painted on the walls in the cave at Lascaux, where the lamp was found.

the only incontrovertible evidence that an object served as a lamp.

We judged that 245 of the 547 putative lamps clearly served other purposes (mortars, other receptacles and so on). The remaining 302 objects were of uncertain status as lamps. We then divided that sample (285 of which have a well-known site of origin) into two categories. We considered 169 of the items to be certain, probable or possible lamps. The other 133 we classified as doubtful or unavailable for study. Markings left by the burning of fuel and wick tend to disappear over time, so the oldest lamps were the most likely to fall into the dubious category. The lamps that we consider here all date from the Upper Paleolithic era, between 40,000 and 11,000 years ago.

The 285 lamps of known origin come from 105 different archaeological sites, mainly in southwest France. The Aquitaine basin has yielded 60 percent of the lamps, the Pyrenean region 15 percent. Considerably fewer lamps have been recovered from other parts of France, and lamps found outside France—in Spain, Germany and Czechoslovakia—are exceedingly rare. Although this pattern may be explained in part by the historically greater intensity of research and the greater number of sites in southwest France, it seems that lamp-producing cultures were in fact restricted to a particular European region.

The vast majority of the known stone lamps consist of limestone or sandstone, both of which are fairly abundant. Limestone has the advantage of often occurring naturally in slab-like shapes that require little alteration. Moreover, limestone conducts heat poorly, so lamps of this material do not get hot enough to burn the user's fingers. Sandstone is a much better heat

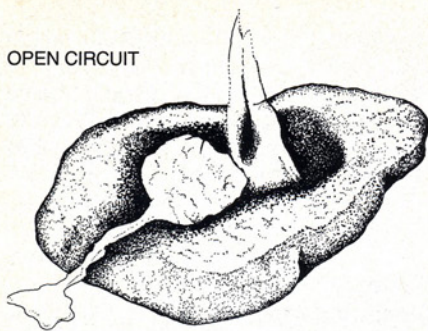
conductor, so simple sandstone lamps quickly become too hot to hold after they are lit. Paleolithic people solved this problem by carving handles into most sandstone lamps. Perhaps part of the appeal of sandstone lay in its attractive red color and smooth texture.

Our experiments suggest that the size and shape of the bowl are the primary factors that control how well a stone lamp functions. Setting bowl shape as our primary criterion, we divided the 302 Upper Paleolithic lamps into three main types: open-circuit lamps, closed-circuit bowl lamps and closed-circuit lamps with carved handles.

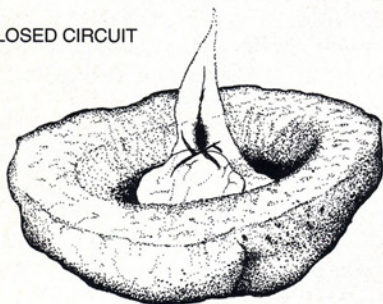
Open-circuit lamps are the simplest kind. They consist of either small, flat or slightly concave slabs or of larger slabs having natural cavities open to one side to allow excess fuel to drain away as the fat melts; the largest ones are roughly 20 centimeters across. Be-



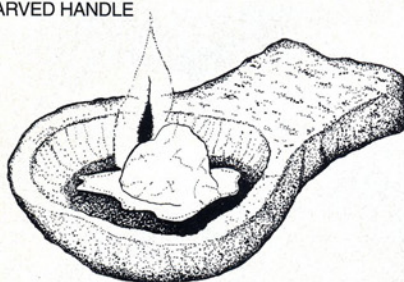
OPEN CIRCUIT



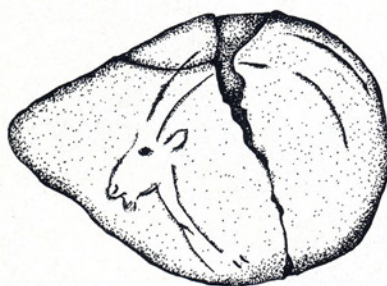
CLOSED CIRCUIT



CARVED HANDLE



LAMP DESIGNS fall into three main categories. Open-circuit lamps (*top*) consist of largely unaltered slabs of rock. When the lamp is lit, melted fat runs off through natural crevices in the rock. Closed-circuit lamps (*middle*) have carved depressions to contain the runoff. Carved-handle, closed-circuit lamps (*bottom*) also have bowl-shaped fuel chambers but are more finely finished and have formed extensions for easier handling. Burn marks indicate that the wick was placed away from the handle.



ENGRAVED DECORATIONS often appear on the sides or bottoms of closed-circuit lamps. This carved-handle lamp, which features the incised image of an ibex, was found at La Mouthe in 1902. It was the first object explicitly identified as a lamp.

cause open-circuit lamps show no noticeable signs of carving or shaping, large numbers of them may have gone unrecognized in premodern excavations. As a result, open-circuit lamps probably are underrepresented in the current sample.

Any slab of rock will work as an open-

circuit lamp, so fashioning one requires extremely little effort. The trade-off is that these kinds of lamps inevitably waste a lot of fuel. Open-circuit lamps may be best interpreted as makeshift or expedient devices, easily made and freely discarded. Studies of the modern Inuit show that human groups, even

those capable of building large, elaborate lamps, occasionally burn a piece of fat on a stone slab when no alternative lies readily at hand.

Closed-circuit bowl lamps are the most common variety. They are found in all regions, in all periods and in all types of sites where lamps have been recovered. Closed-circuit bowl lamps have shallow, circular or oval depressions designed to retain the melted fuel. The recovered lamps of this kind range from crude to elaborate. Some bowl lamps are entirely natural, some have a slightly retouched bowl and others are completely fabricated. The exterior part of the lamp also may be natural, partly retouched or entirely sculpted. These lamps consist of oval or circular pieces of limestone that are usually the size of a fist or slightly larger. The bowl has sloping sides capable of retaining liquid when the lamp is placed on a horizontal surface. A typical bowl measures a few centimeters across but only 15 to 20 millimeters deep. The largest bowls can hold about 10 cubic centimeters of liquid.

Ice Age closed-circuit lamps resemble those employed by certain Inuit peoples—such as the Caribou, Netsilik and Aleut—who had access to wood for fuel and were therefore not dependent on lamps for heat. Inuit living north of the treeline, where wood was scarce, designed large lamps from slabs of soapstone that were up to a meter across. Those giant lamps (perhaps more correctly thought of as stoves) served many of the same functions as hearths elsewhere, including drying clothes, cooking and heating. There may be direct relations between the quality and abundance of locally available wood for fuel, the presence of fireplaces and the form of lamps at a site.

The most intricate lamps are those we classified as closed-circuit lamps with carved handles. The 30 such lamps in our sample are shaped, smoothed and finely finished entirely by abrasion. Each has a carved handle; 11 of them are decorated with engravings. These lamps appear in the archaeological record somewhat later than the others. The first carved-handle lamps show up in either the Solutrean (22,000 to 18,000 years ago) or Lower Magdalenian (18,000 to 15,000 years ago) cultures. They are particularly abundant in the Middle and Upper Magdalenian (15,000 to 11,000 years ago). Most carved-handle lamps are found in the Dordogne region of France. They are most abundant in rock-shelter sites but are also found in caves and open-air camps.

The elegant design, rarity and limited

distribution in time and space of carved-handle lamps may imply that they served primarily ceremonial purposes. A well-known example from Lascaux, which has been dated to 17,500 years ago, was found on the cave floor at the bottom of a vertical shaft, below a drawing of a hunter confronting a wounded bison. This lamp was discovered by the Abbé Glory, a Catholic lay priest who suggested that such lamps were used to burn aromatic twigs and hence were analogous to incense burners. Too few chemical analyses have been performed, however, to test this hypothesis adequately. The other kinds of stone lamps probably served exclusively as sources of light.

To be effective, a fat-burning lamp must be reliable, easy to handle and bright enough to throw usable light a distance of a few meters in, for example, a darkened cave. The form of lamp that predominates in our sample of Paleolithic lamps is precisely that which our experiments revealed to be optimally efficient. It is a closed-circuit lamp having an oval or circular depression and gently sloping rather than vertical sides. Sloping the side of the bowl facilitates emptying the lamp (so that the wick does not become swamped in melted fat) without dislodging the wick. Carving a gap or notch in the rim of the lamp offers an alternative way to empty the bowl while keeping the wick

in place. Eighty percent of the Paleolithic lamps we studied use the sloped-side approach.

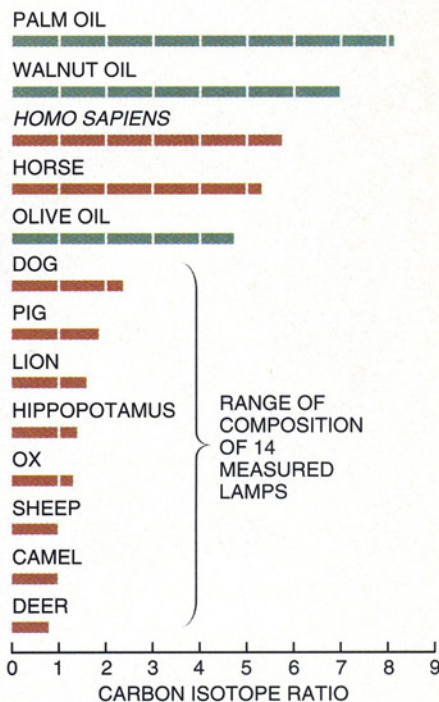
Anthropologists have long assumed that animal fat was the fuel burned in Ice Age lamps. From our experiments, we learned that the best fats are those that melt quickly and at a low temperature. Also, they must not contain too much adipose tissue, the connective tissue in fat. Fat from seals, horses and bovids proved most effective in experimental lamps. But were these in fact the fuels favored by Paleolithic humans?

Guy L. Bourgeois of the University of Bordeaux and de Beaune analyzed residues from several Paleolithic lamps to identify the substances they contained. Using two sensitive chemical analysis techniques (vapor-phase chromatography and mass spectrometry), they measured the carbon isotope ratios in fatty acids in the residues. The abundance ratios resemble those in animal fats from modern herbivores, such as cattle, pigs and horses. Unfortunately, scientists have no samples of fat from the actual animals that lived during the late Pleistocene. Nevertheless, the observed ratios of carbon isotopes are quite unlike those in vegetable fats, proving that animals were indeed the source of fuel for Ice Age lamps.

Our investigations also provided new

information about the materials from which wicks were made. A good wick must be able to attract melted fat by capillary action and convey it to the free, burning end without being too quickly consumed. Of the wicks we tested, lichen (known to be used by modern Inuit), moss and then juniper worked best. Fritz H. Schweingrüber of the Swiss Federal Research Institute for Forest, Snow and Landscape analyzed several lamp residues. He detected remnants of conifers, juniper and grass, as well as nonwoody residues, possibly lichen or moss. In our experience, juniper wicks are never completely consumed by the flame and so may be better preserved than wicks composed of other plants.

The traces of use on our experimental lamps make it possible to interpret with confidence the markings observed on Paleolithic lamps. Those signs of usage come in three broad forms: light accumulations of soot, deposits of charcoal and reddening of the rock itself, a process known as rubefaction. In 80 percent of all the lamps observed, soot and charcoal deposits are situated within or on the rim of the fuel chamber, where one would expect the wick to lie. Occasional blackening of the side or underside of the lamp can be produced by trickles of melted fat that carried with them small particles of soot. Charcoal deposits result from carbonization



EXPERIMENTAL CLOSED-CIRCUIT LAMP (left) clarifies how these objects were used in Paleolithic times. A lump of fat serves as the fuel; the wick consists of bits of bark, lichen or moss. Melted fat collects in a depression in the rock and

must occasionally be poured off. Chemical analysis of Ice Age lamps reveals the presence of residues whose composition resembles that of fat from animals that were common in Paleolithic France (right); vegetable fats clearly were not used.

of the wick or from the heat alteration, or calcination, of adipose tissue in the burning fat.

Thermal reddening often appears on the sides and undersides of lamps, but it, too, most frequently appears in or on the rim of the fuel chamber (in 67.5 percent of the cases). Experience with modern replicas indicates that such reddening took place when hot, melted fat ran onto the side or bottom of the lamp, either as the lamp was being emptied or when it overflowed on its own. Thermal reddening evidently can occur after only a few uses and so provides a helpful indicator of which artifacts served as lamps.

Repeated reuse of a lamp leaves distinct patterns. If a standard open- or closed-circuit lamp is lit on several occasions, the placement of the fat and wick tends to change from one time to the next. Because there is no preferred orientation for those simple lamps, they eventually become blackened and reddened over the entire bowl or surface. The carefully worked closed-circuit lamps that have handles display strikingly different signs of usage. They are oriented the same way each time they are lit, so soot deposits build up

on one part of the bowl only, generally the area opposite the handle.

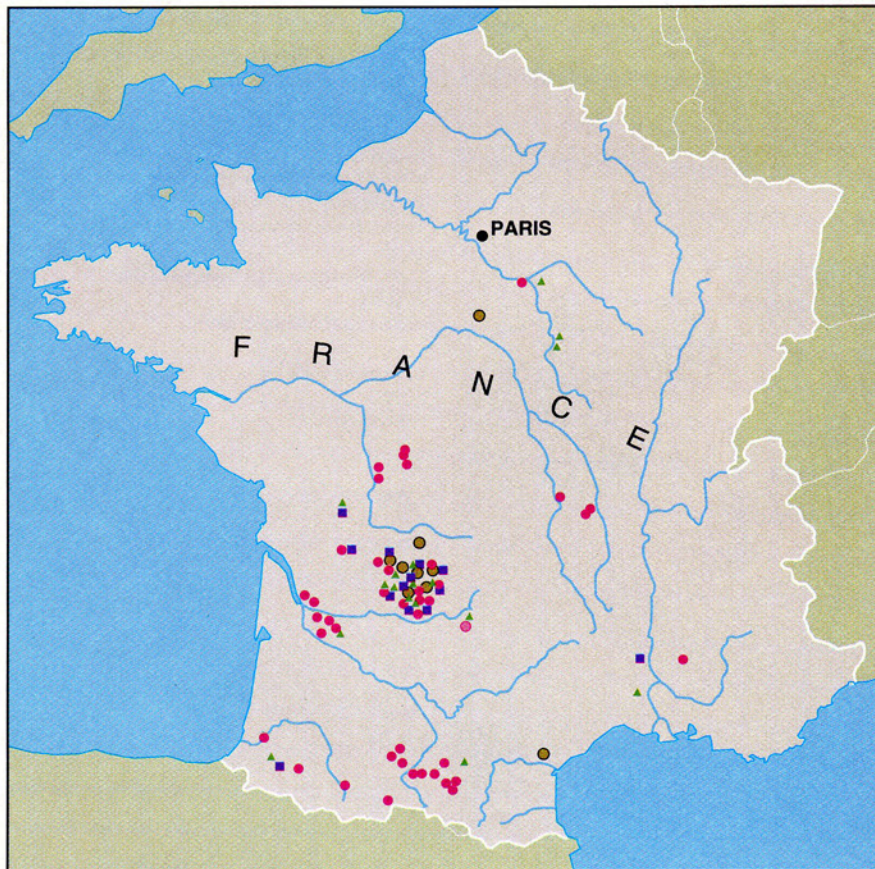
Open-circuit and simple closed-circuit lamps probably were lit only a few times before being discarded. They are so easy to manufacture that there would have existed little incentive to carry them from site to site; we found that we could make a decent lamp in about half an hour. Decorated, carved-handle lamps, which represent a greater investment of labor, were more likely to have been used repeatedly.

To evaluate the effectiveness of Paleolithic fat-burning lamps, one needs to know how much light those lamps could provide. De Beaune investigated this matter by measuring the light output of modern replicas in the metrology laboratories of Kodak-Pathé, France. In quantity, intensity and luminescence, the experimental lamps provided distinctly less light than a standard candle but nonetheless would have been sufficient to guide a person through a cave or to illuminate fine work when placed nearby—assuming, of course, that the visual acuity of Paleolithic people was the same as ours.

The limitations of Ice Age lamps sug-

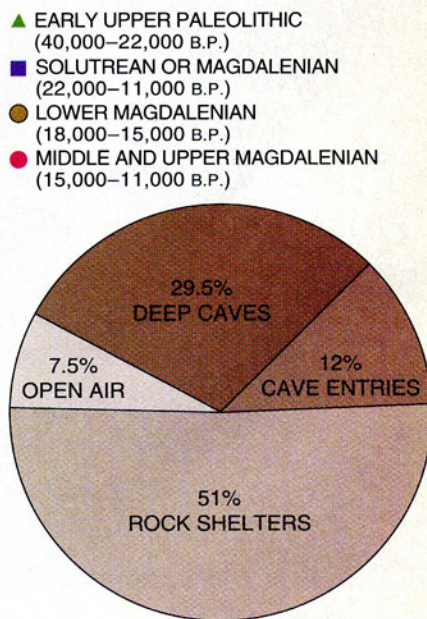
gest that the creators of cave drawings never saw them as they appear in modern photographs. Human color perception is constrained and distorted at levels less than 150 lux (for comparison, 1,000 lux is typical in a well-lit office). It seems doubtful that the creators of the cave art worked under such bright conditions. Achieving full and accurate color perception of the cave images along a five-meter-long panel would require 150 lamps, each of them placed 50 centimeters from the cave wall. Torches could have provided supplementary light, but few traces of torches have been found in deep caves. On the other hand, the absence or scarcity of lamps in vast cave galleries such as those at Rouffignac, Niaux and Les Trois Frères implies that the creator of the paintings had access to some alternative light sources.

Today when one views the famous cave art in France and Spain, the artificial illumination creates an effect fundamentally unlike that experienced by Paleolithic visitors. Electric lights in the cave of Font de Gaume yield a steady light level of about 20 to 40 lux across a full panel of drawings. Ten to 15 thoughtfully placed stone lamps would be needed to attain 20 lux. A person carrying a single lamp would get a very different impression of the cave art and could view only small portions of the wall at a time. The dim illumination produced by flickering lamps may well have been part of the desired effect of viewing art deep within a cave. The illusion



ICE AGE LAMPS have been found primarily in southwest France (left). Lamps appear in all eras of the Upper Paleolithic (40,000 to 11,000 years ago); more of them have been recov-

ered from the later periods. Surprisingly, most lamps have been retrieved not from deep caves but from open-air sites and from under rock shelters (right).



of animals suddenly materializing out of the darkness is a powerful one, and some cave images are all the more convincing if one cannot see them too well.

Of course, fat-burning lamps were employed for many tasks other than creating and viewing cave art. Lamps are found in such abundance at sites throughout southwest France that they must have been a fairly ordinary item of day-to-day existence. Only about 30 percent of the known lamps were recovered in deep caves. Open-air sites, rock shelters exposed to plentiful daylight and cave entries have provided the rest. The number of lamps at each site (two to three, on average) does not differ significantly from caves to rock shelters to open-air sites.

The location of lamps within sites provides clues to how people exploited them. In deep caves, lamps are often recovered from places where people had to pass, such as cave entrances, the intersections of different galleries and along walls. It would seem that lamps were placed at strategic or predictable points where they could easily be found and reused. The discovery of many lamps lying together—most notably at Lascaux, where 70 lamps have been recovered—implies that lamps were stored in particular locations between uses. Unfortunately, one cannot deduce how many of the lamps were lit at any one time.

Lamps are frequently discovered near fireplaces. Perhaps they were preheated in the fire in order to warm the fat and make it easier to ignite or were abandoned and reused as hearthstones. More likely, fireplaces served as central points of heat and light from which people departed into and returned from the darkness. Many lamps are found inverted in the soil, implying that on returning, people extinguished them simply by turning them over.

In at least one location, a lamp seems to have provided a permanent, fixed source of light within a campsite. Archaeologists found two lamps in a small, natural cavity in the wall of the rock shelter of La Garenne. One lamp had been turned over as if to extinguish the flame. The other was placed upright in a natural hollow in the rock that held it level. The cavity itself would have served as a natural reflector that maximized the lamp's light output.

Sorting through the sample of fat-burning lamps, we sought to learn how their abundance and design changed over time. That analysis is somewhat restricted by the paucity of data. Accurate radioactive dates are available for only the most recently discovered lamps. In most cases, ages are inferred



CAVE ART must have required artificial illumination both to create it and to view it. The dim, flickering light provided by fat-burning lamps may have been integral to the intended appearance of these subterranean paintings.

from the archaeological levels in which the lamps were found, and in many early excavations even that information was not recorded. Nevertheless, enough information exists for us to make some general observations.

Many more lamps appear in the last cultural period of the Upper Paleolithic, the Magdalenian, than in preceding periods. This may reflect the fact that there are simply more Magdalenian sites known than is the case for earlier periods, as well as the fact that most deep-cave painting took place in the Magdalenian. Older lamps are also harder to identify with certainty.

The form of lamps seems to have evolved surprisingly little through the ages. Some variation in form, material and design occurred, but there is no clear progression from crude to elaborate. Although carved-handle lamps are more common in the later eras, all three primary types of lamp are found throughout the Magdalenian, and even the most elaborate lamp designs date back to the earliest Upper Paleolithic periods, which roughly corresponds to the time when Cro-Magnon, anatomically modern humans, appeared in Europe. The various forms of lamp most likely represent functional responses to particular contexts of use; the need for both simple, easy-to-make lamps and carved, aesthetically pleasing ones apparently was common to all Paleolithic cultures in France.

It is difficult to overstate the impor-

tance of artificial light in freeing humans from their evolutionary adaptation to the daylight world. Cave art specialist Denis Vialou of the Museum of Natural History in Paris lauds the Magdalenian cave artists as the people who conquered the world of the underground. But perhaps it is more accurate to see them as the most daring of a long line of our Cro-Magnon ancestors, who, through intelligence and technological innovation, changed the human experience forever by domesticating the realm of darkness.

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